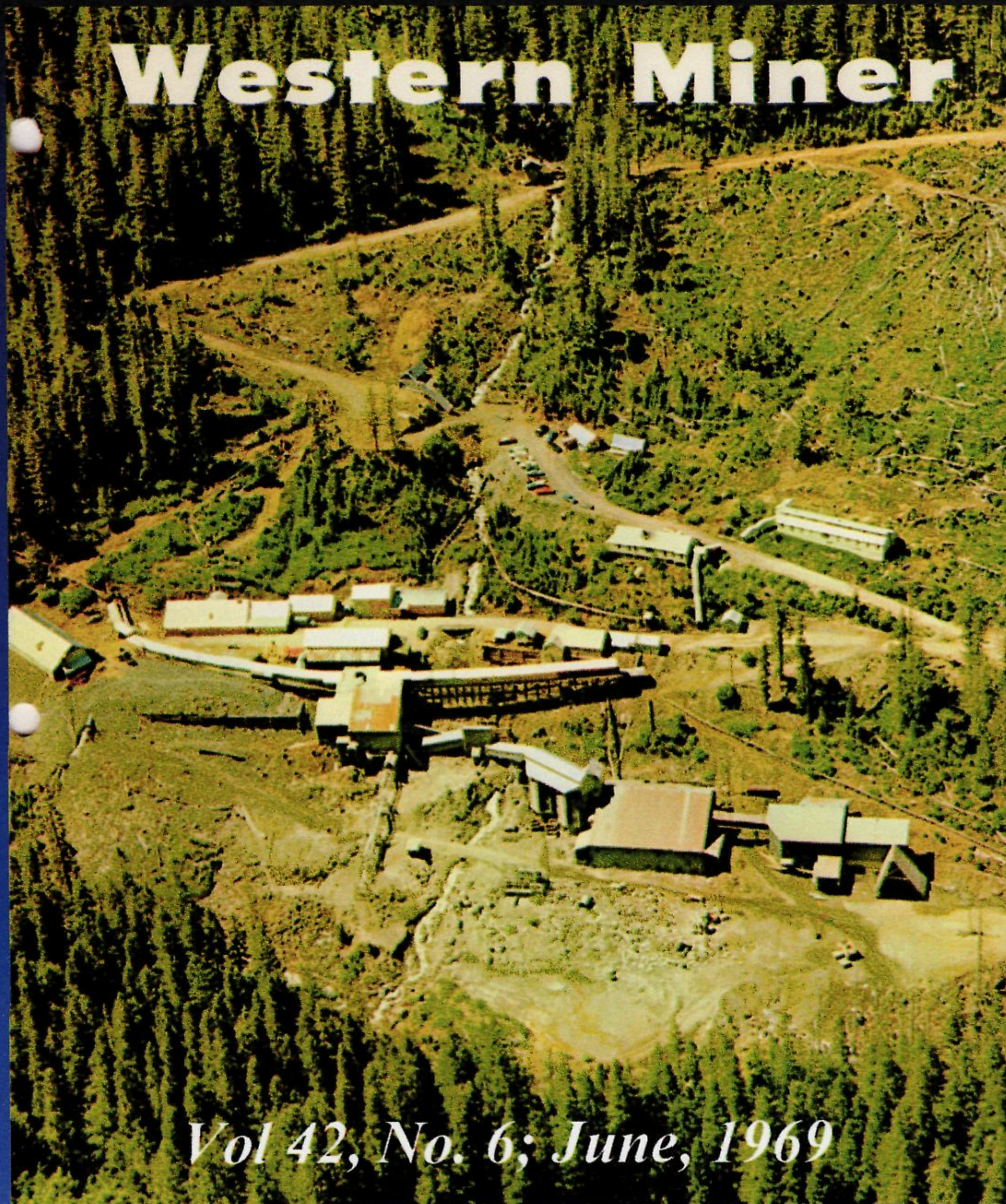
GIANT MASCOT Ni-CU MINE HOPE, B.C. 1958-1974



MINE FACTS AND FIGURES

- The Pacific Nickel property was located in 1923 and substantially developed in the 1930s and 1950s.
- The mine produced 4 200 000 tonnes grading 0.77% Ni and 0.34% Cu between 1958 and 1974.
- The operation employed approximately 185 people.
- The mill processed 1270 tonnes/day and produced nickel and copper flotation concentrates.
- The mine produced 26 573 090 kg nickel and 13 212 770 kg copper.

The mill was rebuilt after a fire in August 1970:

The Brunswick #2 stope collapsed November, 1968.

REGIONAL SIGNIFICANCE

- The ultramafic rocks are cumulates remoblized as crystal mush and injected along a deep crustal structure.
- The mush contained entrained sulpide melt, which formed (1) zoned, disseminated and (2) unzoned, massive sulphide deposits.
- The host fault separates Harrison Lake terrane rocks from Cogburn Schists (Bridge River and Hozameen Group equivalents).
- The fault extends to the northwest into the headwaters of the Mehatl River. It is cut by the Hope Fault, but should reappear south of the Fraser River.
- The Coquihalla serpentinite is cumulate in origin (Ray, 1990). It could contain magmatic sulphides.

ORE DEPOSITS

- Reserves found in 26 pipes, but 66% of production came from five deposits (4600, Pride of Emory, 1500, Brunswick #2, & #5).
- Zoned deposits (4600, Brunswick #5) contain disseminated sulphide in one or more rock type and display gradational tenor.
- Unzoned deposits (Pride of Emory, Brunswick #2) contain massive sulphide and have sharp contacts. They are commonly fault or contact controlled.
- Most of the oreshoots plunge steeply to the northwest. Some are cut-out by faults. Others project to depth.
- Most of the faulting and alteration observed is post-mineral in age.

GIANT MASCOT MINE
ZONED AND UNZONED ORE PIPES
A. Aho (1956)

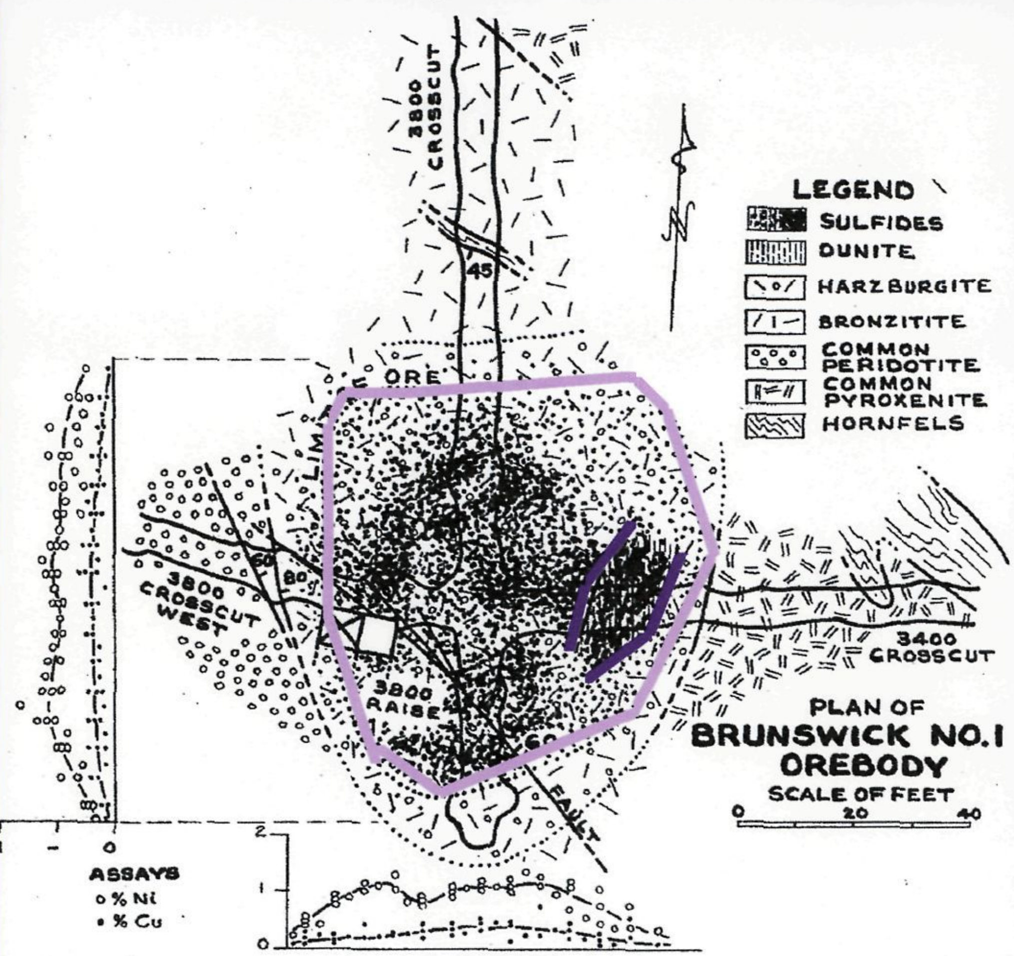


FIG. 7.

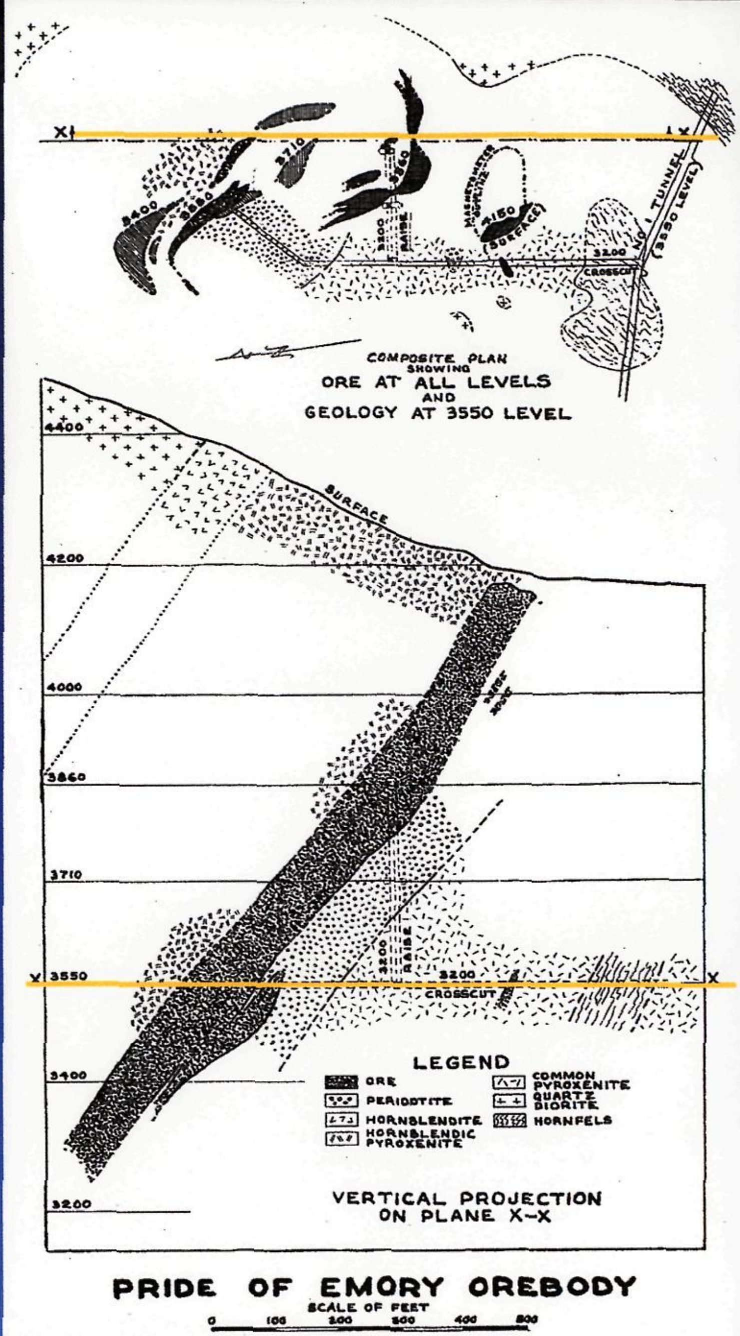
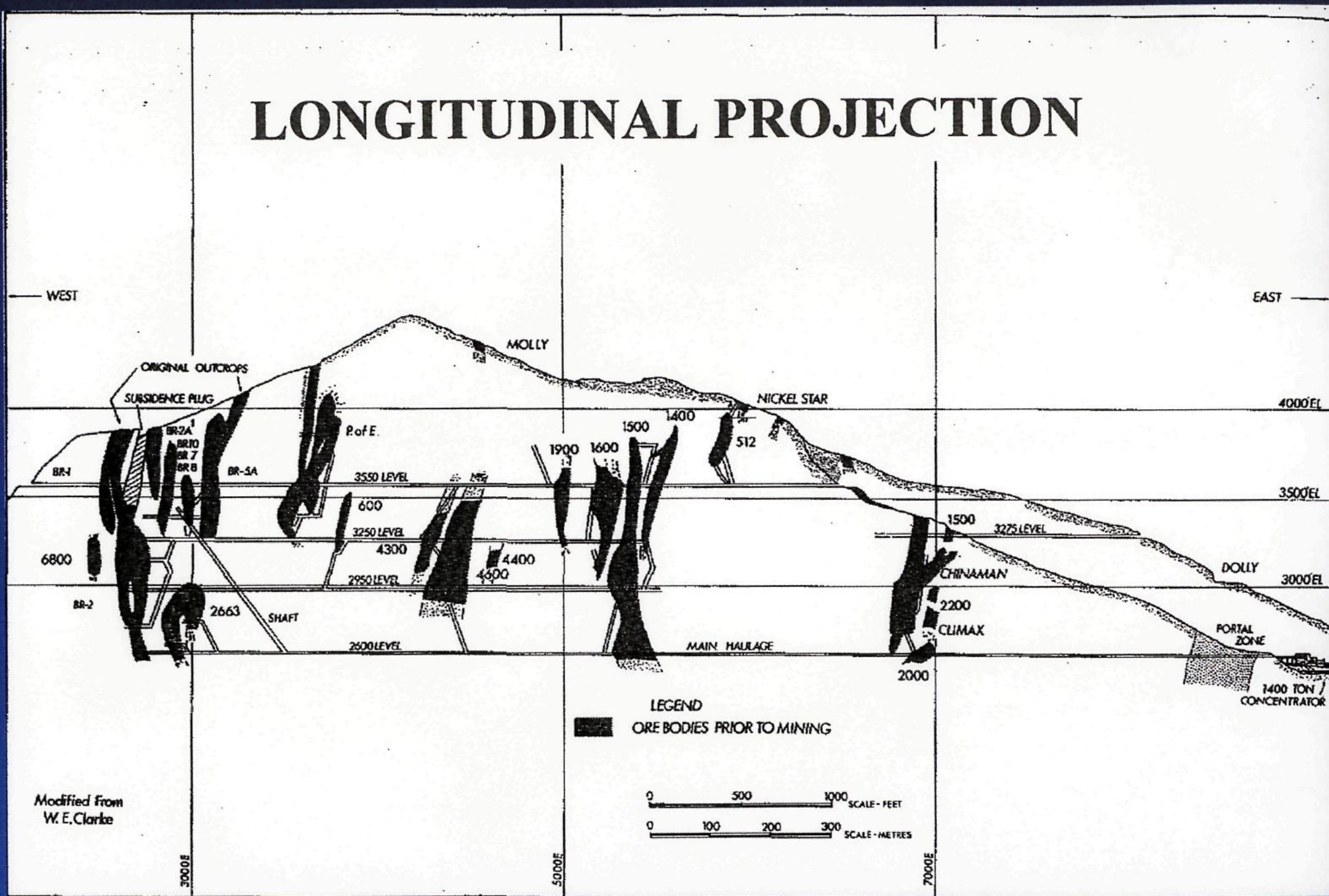


FIG. 11.

GEOLOGY

- The deposits are in a small (2x3 km) plug of ultramafic rock emplaced in high-grade metasedimentary rock along a section of a major crustal structure (Bridge River Suture).
- The plug probably cuts a late, post kinematic pluton (Spuzzum pluton).
- It is largely composed of pyroxenite and hornblende pyroxenite, however there is appreciable dunite and peridotite at the west end. The units are gradational and also cross-cutting.
- The deposits commonly occur in small (<100 m diametre) pipes that are cored by dunite and enveloped by peridotite and pyroxenite.

GIANT MASCOT DEPOSIT



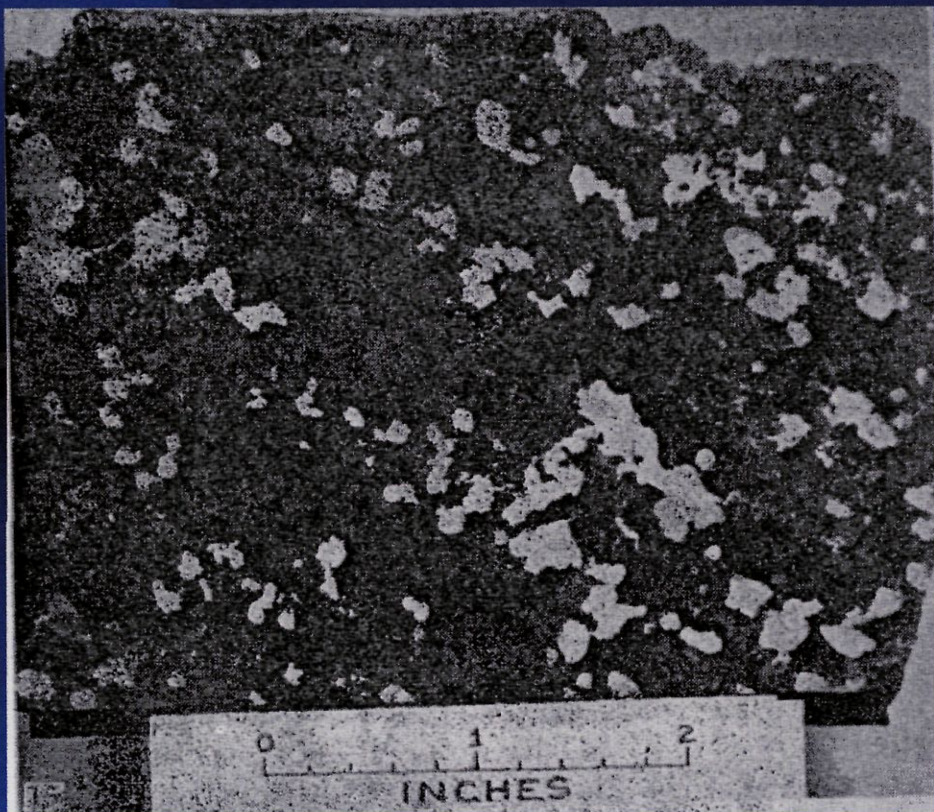
P.A. Christopher and J.W. Robinson;
Geology Exploration and Mining, 1974

SULPHIDE MINERALOGY

- The sulphides locally enclose fresh olivine and pyroxene crystals, indicating formation at high temperature.
- Primary sulphides include pyrrhotite, pentlandite, chalcopyrite and pyrite. All four phases exsolved from an original single-phase magmatic sulphide during cooling.
- The primary metals are nickel and copper, however old records show that there is local enrichment of Pt, Pd, Au and Ag.
- A bulk sample collected in 1936 averaged 2.74 g/t Pt and Pd and 0.68 g/t Au. A “high-grade” sample from 1500 orebody graded 7.24% Ni, 17.1% Cu, 2.85 g/t Pt, 4.94 g/t Pd and 0.93 g/t Au.
- Surface sampling in 1987 gave erratic results.

GIANT MASCOT ORE TYPES

ZONED-1900



UNZONED-2600 LEVEL

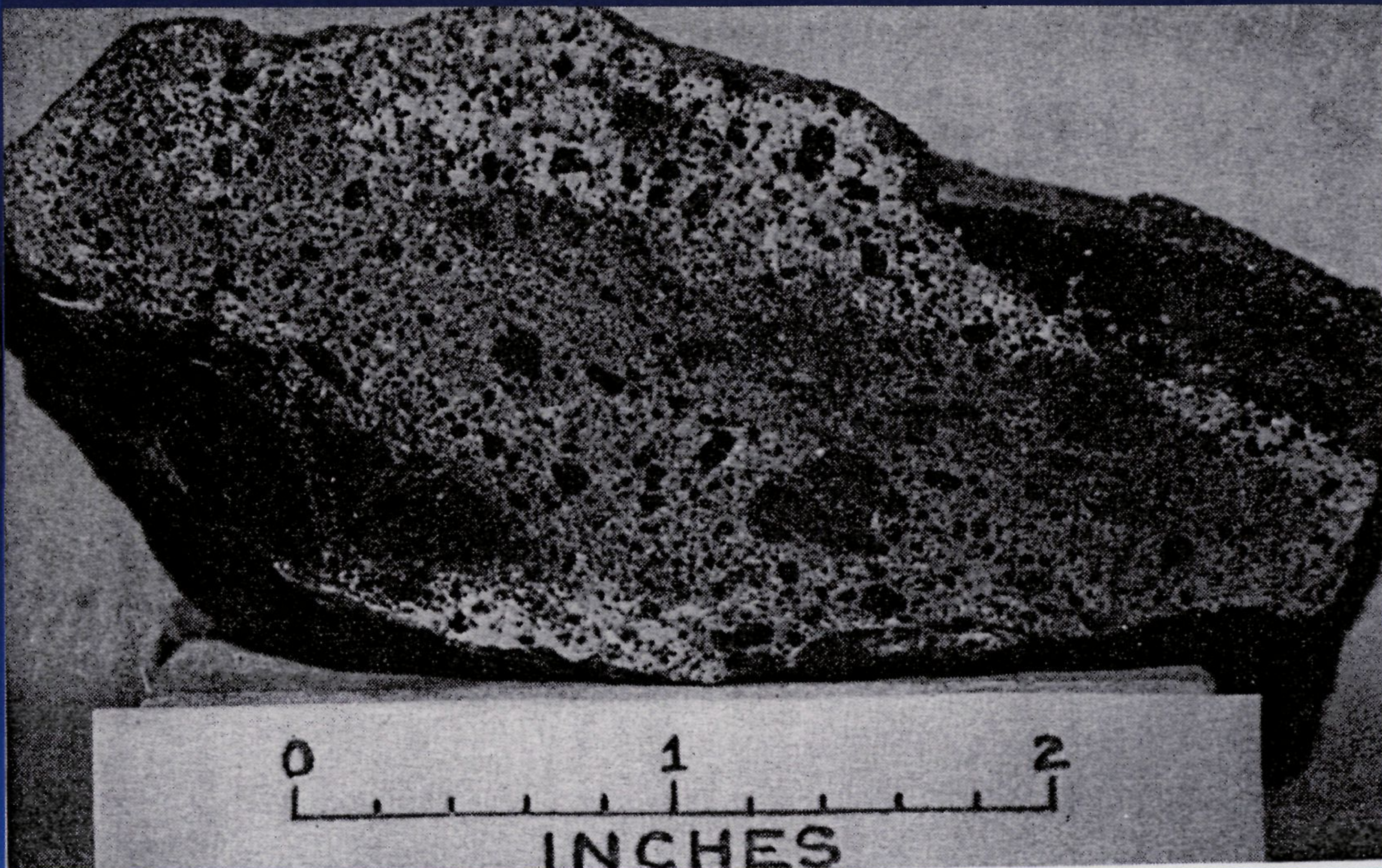
A. Aho: Economic Geology, Volume 51, p444-481 (1956)

GIANT MASCOT MINER

Jackleg Drill, Giant Mascot Mines Limited; Western Miner and Oil Review, April, 1963

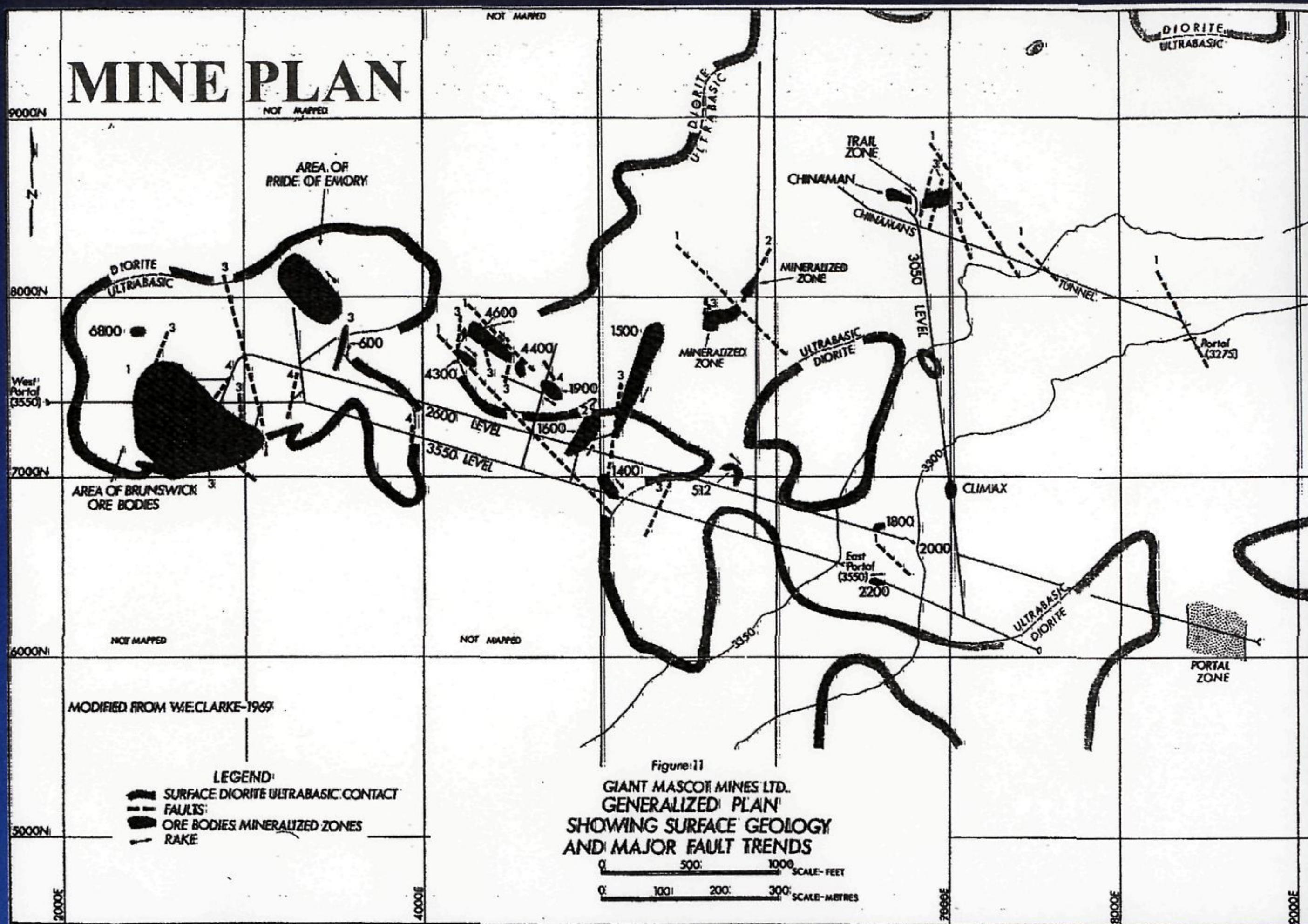
GIANT MASCOT ORE TYPES

UNZONED; VEIN: 512 CROSSCUT



A. Aho: Economic Geology, Volume 51, p444-481 (1956)

GIANT MASCOT DEPOSIT



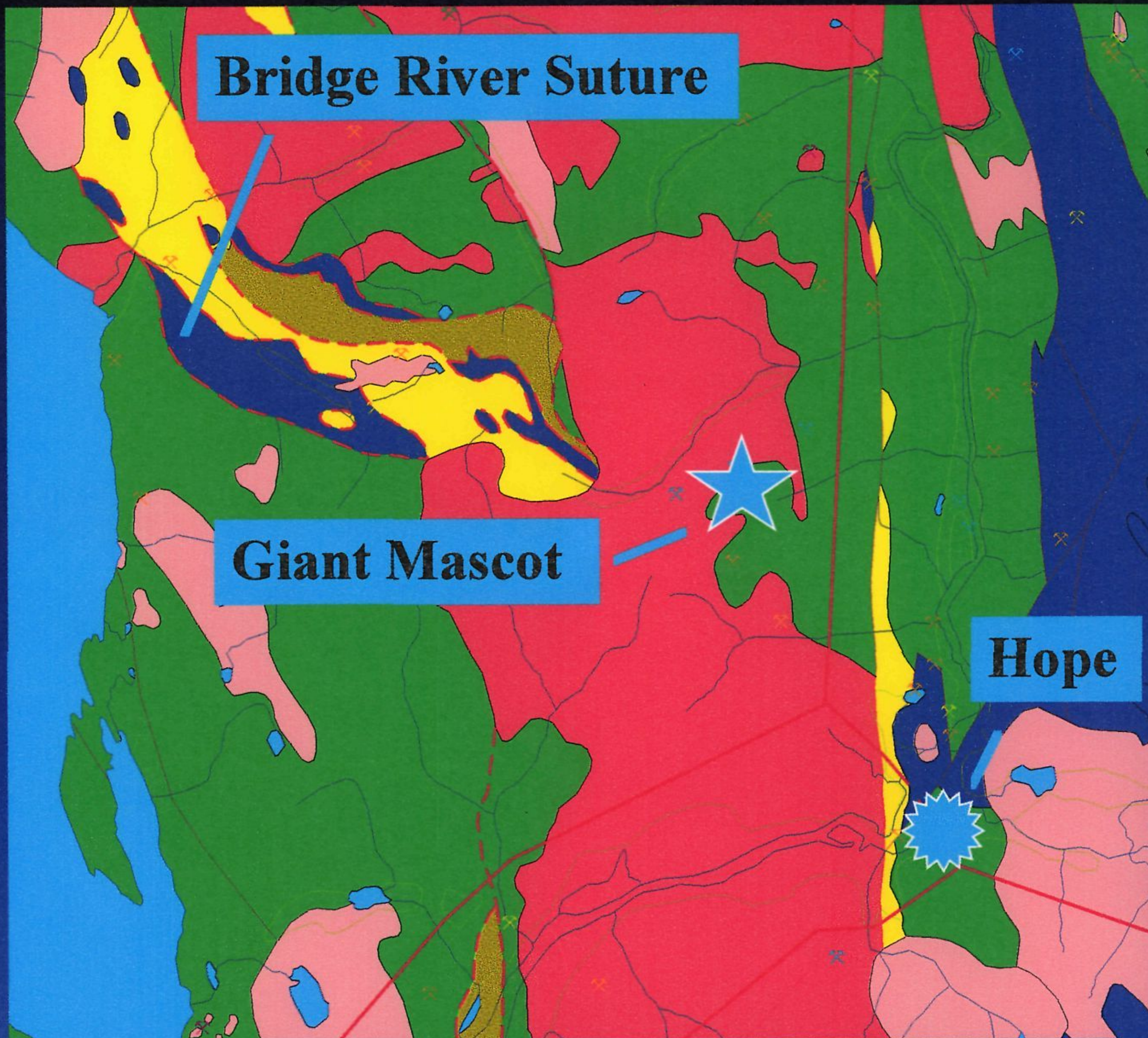
P.A. Christopher and J.W. Robinson; Geology Exploration and Mining, 1974

GIANT MASCOT MINE

- MINE FACTS AND FIGURES
- GEOLOGY
- ORE DEPOSITS
- SULPHIDE MINERALOGY
- REGIONAL SETTING

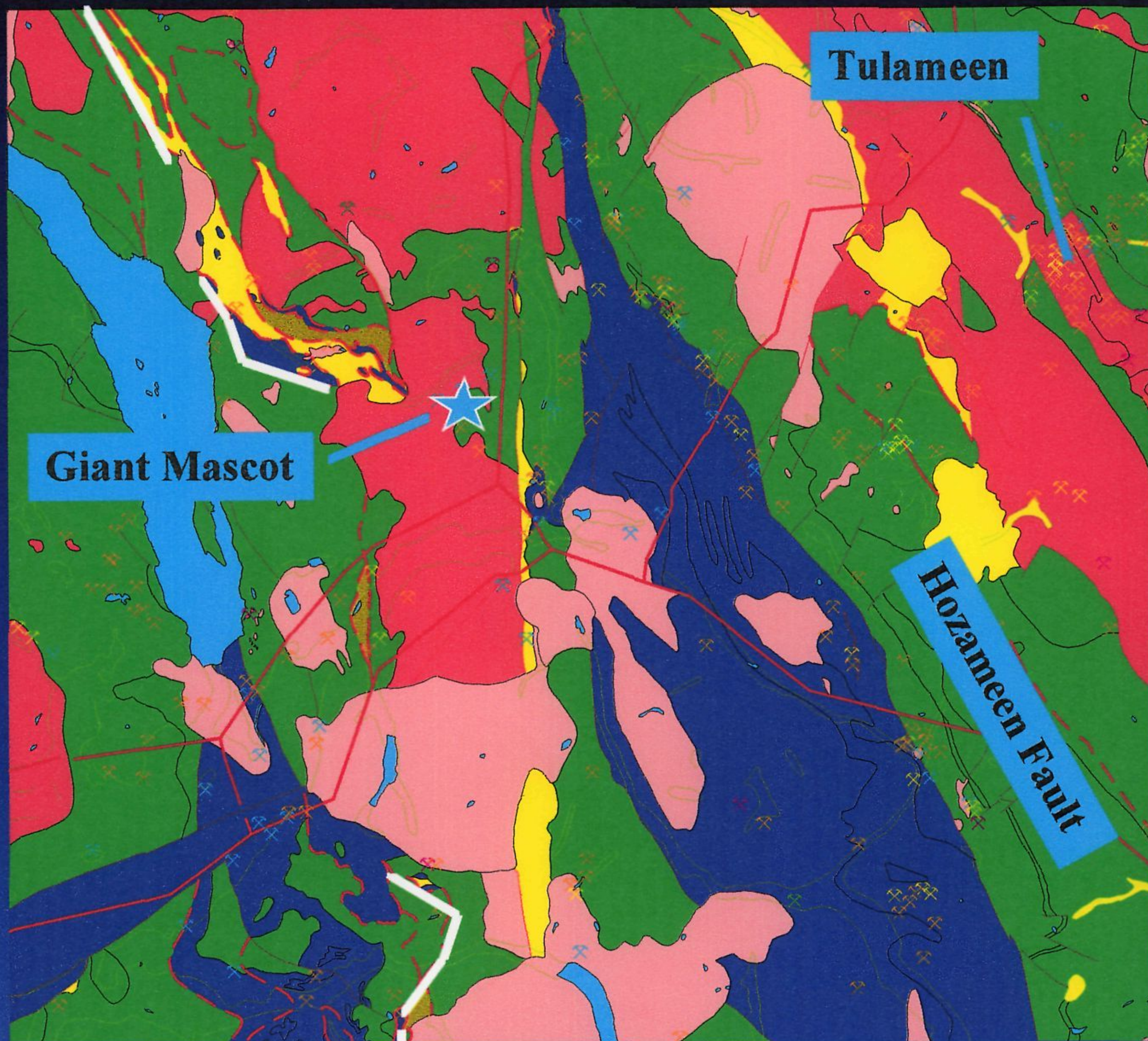
The mine is owned by Homestake Canada Inc.. The information for this report comes from public domain sources quoted in MINFILE.

GIANT MASCOT GEOLOGY

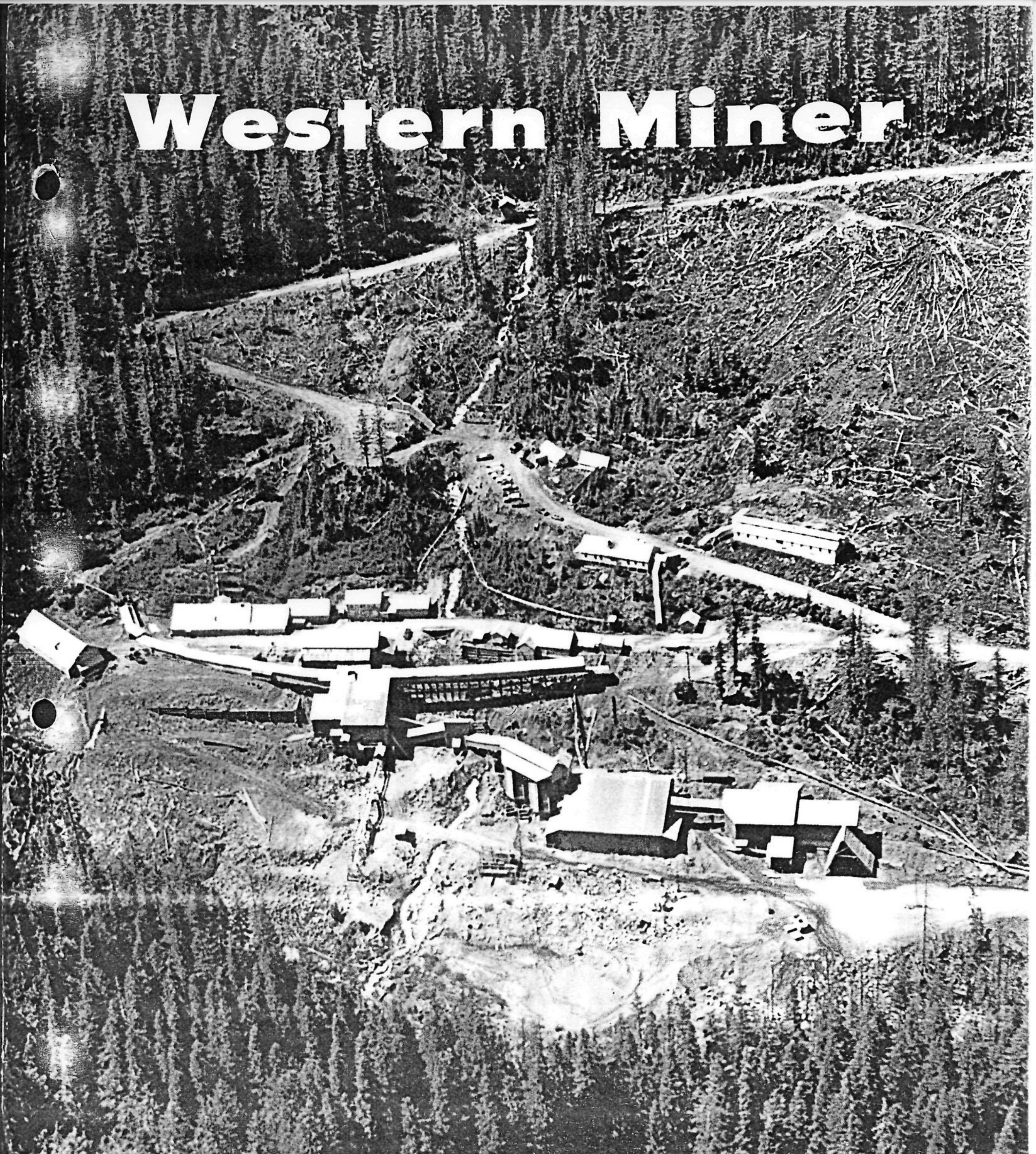


The MapPlace

REGIONAL GEOLOGY



The MapPlace



GIANT MASCOT MINES LIMITED

JUNE, 1969
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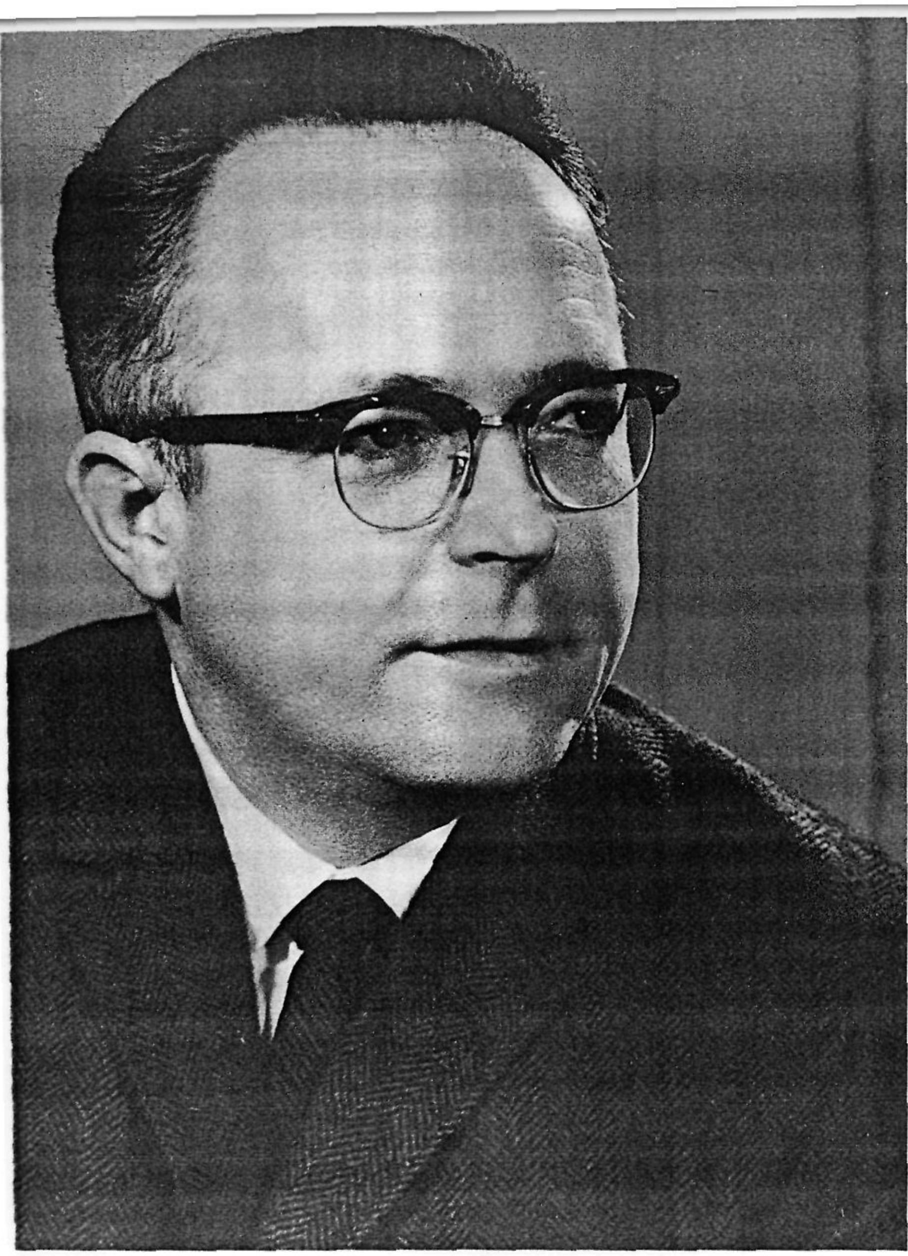
June, 1969, p.p. 34 and 37-46 inclusive



Mining Man of the Month

LOUIS PHILIP STARCK, B.A.Sc., P.Eng.

"Lou" Starck, the managing director of Giant Mascot Mines Limited, is a mining engineer with an enviable record of operating success.

He was born in Vancouver December 31, 1923. He received his public and high school education in Vancouver and graduated from The University of British Columbia in mining engineering in 1947, after which he did post-graduate work in metallurgy.

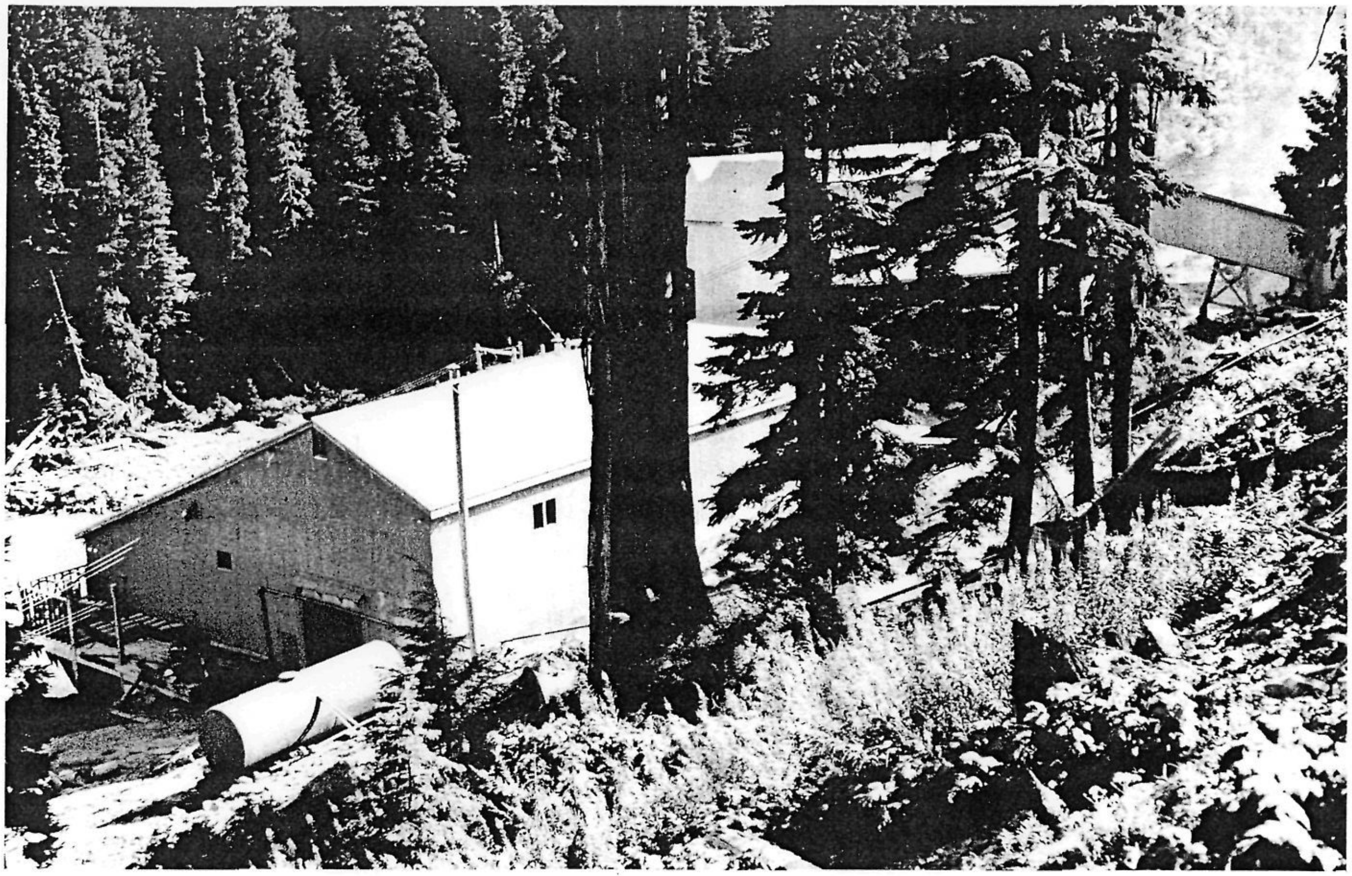
In the summers of 1946 and 1947 he was employed at Ollala by Hedley Monarch Mines. In 1948 he joined the staff of Canadian Exploration Limited at Salmo and for the following two years was assistant superintendent of the lead-zinc mill and superintendent of the tungsten mill. In 1950, he was exploration scout for the consulting firm of Hill, Legg, Hemsworth, and Grimwood. In 1951, he was sent to Spillimacheen to advise on operating problems at the Giant Mascot lead-zinc mine and within three months was made manager of the operation.

In the following four years, the Spillimacheen project prospered. In 1955, Mr. Starck returned to Vancouver to join the consulting firm of Henry L. Hill & Associates Ltd., which in 1959 became Hill, Starck & Associates Ltd. For several years the firm was consulting manager for Giant Mascot Mines, Silbak Premier Mines, Cronin Babine Mines, Trojan Consolidated Mines, Quatsino Copper-Gold Mines, and a number of other operating companies and as straight consultant to others in the exploration stage.

When Giant Mascot Mines purchased the B.C. Nickel mine and plant from Newmont Mining Corporation of Canada in 1959, Lou was drafted to handle the operating end and in following years maintained residence at the mine for a great deal of his time. The spectacular success of this reclamation and rehabilitation is widely known and is reported in some detail in this issue of Western Miner.

In 1965, Mr. Starck resigned from the consulting-engineering firm to become managing director of Giant Mascot Mines on a full-time basis. At the present time he is vice-president and managing director of Giant Mascot Mines; president of Giant Explorations Limited; and vice-president of Brameda Resources Ltd.

He is a member of the Institution of Mining and Metallurgy; the Canadian Institute of Mining and Metallurgy; the American Institute of Mining, Metallurgical, and Petroleum Engineers; and of the Association of Professional Engineers of British Columbia. With Mrs. Starck, he resides at 3958 Bayridge Court, West Vancouver, B.C.



A view of the Giant Mascot mill from the west.

Giant Mascot Mines Limited

AN ACHIEVEMENT OF RECORD

By FRED H. STEPHENS
Associate Editor, Western Miner

Since Giant Mascot Mines Limited commenced production at the property previously known as the "B.C. Nickel" mine in July 1959, the value of concentrates shipped has exceeded $27 million. For the first eight months nickel concentrate was shipped to the Fort Saskatchewan refinery of Sherritt Gordon Mines Limited and copper concentrate to the Tacoma smelter of American Smelting and Refining Company. In March 1960, Giant Mascot effected a sales contract with Sumitomo Metal Mining Co. Ltd. under which a bulk nickel-copper concentrate has since that time been shipped to Japan.

It must be borne in mind that payment received has been for concentrates. In terms of contained metal the value is estimated to be well over $40 million.

Giant Mascot purchased the property from Newmont Mining Corporation of Canada Limited at a cost of approximately one million dollars. The operation has provided dividends of $1.2 million, built up working capital of approximately the same figure, and paid almost $11 million in wages and salaries. At the same time, the company has expended $7½ million in the purchase of machinery, equipment, and services; with electric power ($1,250,000), explosives ($1,000,000), and drilling supplies ($600,000) being the principal items.

Funds generated by the Giant Mascot operations have also provided nearly one million dollars for the purchase, exploration, and development of the Giant Copper (Canam) property; and enabled the company to gain 100 per cent ownership of the Giant Soo (Estella) lead-zinc property.

Minewise the record is equally impressive. When operation commenced in 1959, ore reserves were estimated at 745,000 tons grading 1.16% nickel and 0.39% copper. At September 30, 1968, end of the company's last fiscal year, the reserve was calculated at 897,241 tons grading 0.96% nickel and 0.52% copper. The reserve has since been assessed at more than one million tons with a grade of 0.95% nickel and 0.50% copper. The increase has resulted from follow-up drilling in the 4,300 and 4,600 orebodies. Recent drill holes have cut widths in excess of 60 feet with assays up to 2% nickel and 1.5% copper, although such are not claimed as being representative.

During the summers of 1967 and 1968, Sumiko Consultants and the Japan Consulting Institute conducted a detailed surface geological and geochemical examination. This work disclosed the presence of five new mineralized areas, which contain 20 local areas of interest. Two of the anomalies sampled to date have yielded values exceeding 1% nickel and 1% copper.

A continuing geological study is being made by Walter E. Clarke, B.Sc., consulting geological engineer, and an interesting interpretation is presented in this issue of Western Miner, commencing on page 40.

DEVELOPMENT PROGRAMME

The following excerpt from the report of president J. Austin to shareholders, dated May 15, 1969, describes the situation:

"Under a continuing programme of ore-reserve development there has been an increase in total reserves during the past six months by 20 per cent to a total proven and probable tonnage reserve in excess of one million tons grading 0.95% nickel and 0.50% copper.

"In February 1969, the Directors authorized detailed geological studies with a view to developing a major exploration programme having as its objective a substantial increase in ore reserves on the property within the next two years to permit a target of 3,000 tons-per-day milling capacity to be achieved.

"The first stage of this major exploration programme will be started within the next six weeks and will consist of a programme of long-hole drilling to explore the favourable ore host ultra-basic formations for 1,000 to 1,500 feet to the north and south of the adit levels. It is this type of long-hole diamond drilling that successfully located the 4,300 and 4,600 zones which have developed large tonnages of spectacular high-grade ore in recent months.

"The first phase of this programme, consisting of some 40 holes aggregating 50,000 feet, will be undertaken on the 3,550 and 3,275 levels at an approximate cost of $350,000. The second phase, involving essentially the same footage, will be concentrated above and below the 2,600 main-haulage level.

"As this programme is supplementary to the normal diamond-drilling programme of some 50,000 feet annually, electric drills will be employed. This will be the first time that electric machines have been used for underground exploration in British Columbia and will eliminate the need to install additional compressed-air capacity at the property.

"To further assist in developing new ore zones, the programme of re-evaluating and postulating new hypotheses on the ore controls that was strated two years ago with the re-geologizing of the surface exposures, has been extended to the underground workings during recent months with promising results."

PRODUCTION

To May 31, 1969, Giant Mascot Mines milled 3,041,726 tons of ore and produced 38½ million pounds of nickel and 17½ million pounds of copper. The concentrator is currently operating at 1400 tons daily, five days a week. All concentrate is hauled to the terminal facilities of Vancouver Wharves Ltd. in North Vancouver in company-owned trucks and trailers.

As to mining methods and practice, Frank Holland, resident manager, states:

"Mining and extraction methods, although undergoing continuing evolution and refinement, in the search for greater efficiencies, are the tried and tested methods of previous years. That this approach is sound is indicated by the relatively stable cost position in the face of continually climbing labour and supply costs".

At last report the total complement was 185, including 29 members of staff; 20 men in the concentrator and crushing plant; 27 on surface and in shops, including underground maintenance; 4 on concentrate haulage; and 150 men in the mine.

Actually the present complement is above the average figure. Extra geological, engineering, and supervisory personnel are carried on staff to provide for resumption of activity at the Giant Copper operation. Also development and drilling crews are at an all-time high as a result of the increase in these activities. Supervision of the Giant Copper project is made from the Giant Mascot office at Hope. The accounting office, headed by George Audet, performs the bulk of the accounting procedures for all Giant Mascot operations as well as those of the subsidiaries G. M. Explorations Limited and Giant Explorations Limited.

PERSONNEL

Senior personnel of the company includes: W. C. Gibson, chairman of the board; J. Austin, president; L. P. Starck, P.Eng., vice-president and managing director; M. E. Davis, vice-president, finance.

Walter E. Clarke, B.Sc., P.Eng., of Vancouver is the company's geological consultant.

Senior operating personnel includes: Frank Holland, resident manager; George Bosnich, general and concentrator superintendent; John Hungle, mine superintendent; Orvil Gilroy, surface and mechanical superintendent; Len Allan, senior mining engineer; John Yu, chief mine engineer; G. Audet, chief accountant; and L. DeRoux, chief geologist.

E. R. Gayfer, P.Eng., chief engineer, supervises the company's field crews through Giant Explorations Limited.

Other supervisory mine personnel includes: M. Cawston, B. Woodin, and A. Kuiack, mine foreman; C. Martindale, diamond-drill foreman; and A. Gannon, Tom Smith, D. Cook, Ted Smith, Wm. Stark, and R. Klyne, shift bosses.

Engineering and geological personnel under the general direction of Len Allan includes: S. C. Yu, B.Sc., chief mine engineer; F. Elek, C.E., mine engineer; B. G. Hawkins, chief surveyor; J. Haight, B.Sc., and I. Murray, B.Sc., geologists; D. Botfield, surveyor; R. Harrison, draughtsman and surveyor; and Martin Ould, B.Sc., ventilation and noise-control engineer.

In the concentrator, H. Tice and J. Wadsworth are foremen. D. Thornbury is mechanical electrical foreman and C. Walther is surface foreman.

The accounting staff under George Audet includes: Mrs. L. Kirilows, assistant accountant; Mrs. A. Taylor, timekeeper; Mrs. J. Roberts, stenographer; and Walter Inouye, warehouseman and purchasing agent.

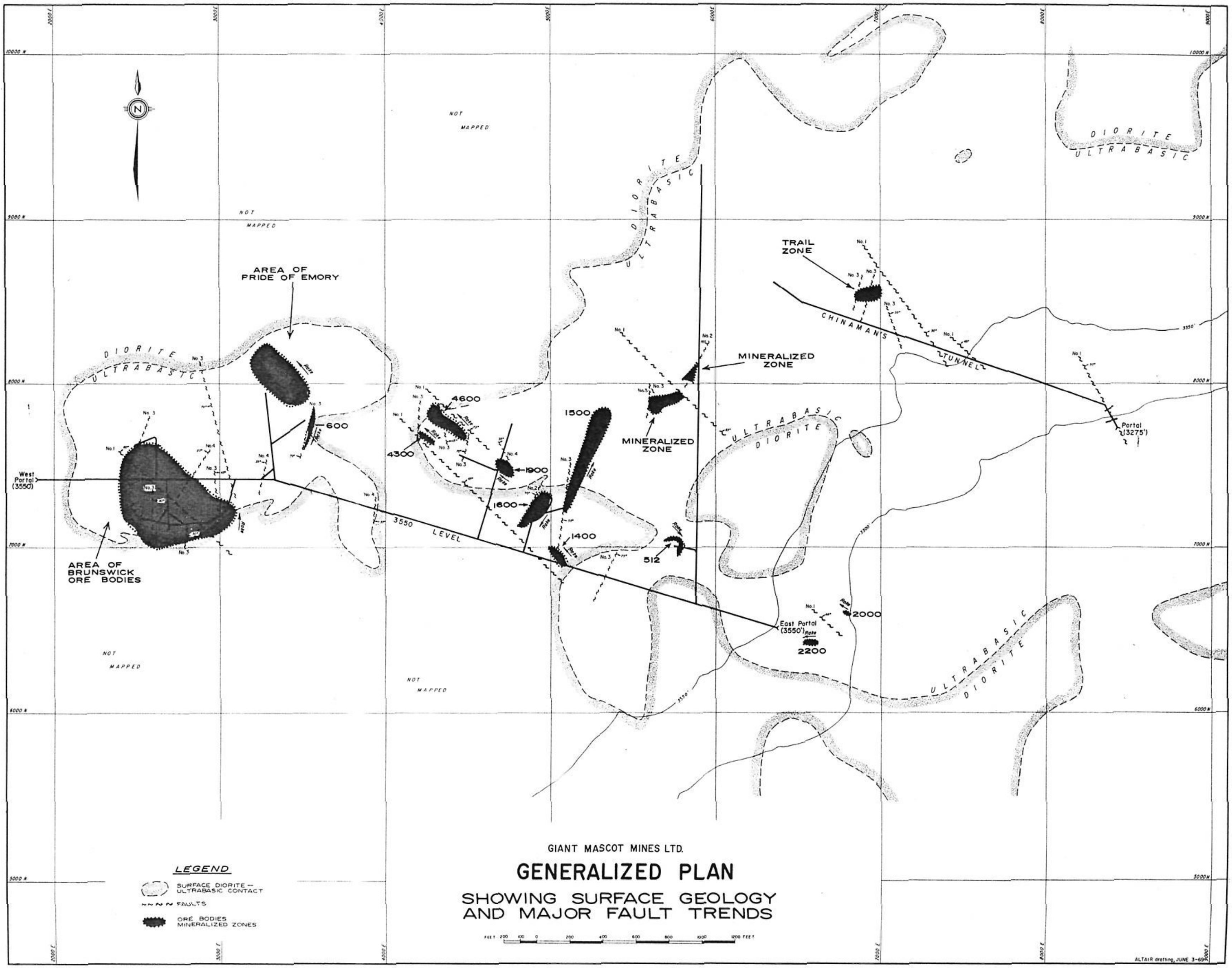
CONCLUSIONS

In this day of big-tonnage, multi-million-dollar mining projects, the continuous success and expansion, of the modest-tonnage, moderate-grade operations of Giant Mascot Mines prove there is still room for the smaller operation if handled by competent personnel. It is interesting to note that almost without exception, any staff member who has left the company has gone on to a position of responsibility and authority in the mining industry; an observation which could indicate that such conventional procedures as those employed at Hope provide valuable experience in mine supervision.

The assistance of L. P. Starck, Walter E. Clarke, and in particular Frank Holland, is gratefully acknowledged in the preparation of this report.

Above, **Back Row,** from left: L. L. Allan, senior engineer; G. H. Audet, chief accountant; O. Gilroy, surface and mechanical superindent; Frank Holland, resident manager; and J. Austin, president. **Centre Row,** from left: J. Hungle, mine superintendent, and L. DeRoux, geologist. **Front Row,** from left: L. P. Starck, vice-president and managing director; G. Bosnich, general superintendent; M. M. Menzies, director; and J. Yu, chief engineer.

Below, **Back Row,** from left: T. McLaren, chief assayer; D. Black, assistant assayer; R. K. Rogers, bucker; J. Haight, geologist; G. H. Audet, chief accountant; L. DeRoux, geologist; L. Allan, senior engineer; and E. Elek, long-hole engineer. **Front Row,** from left: W. Inouye, warehouseman; R. Harrison, draughtsman; Mrs. L. Kirilows, assistant accountant; Mrs. A. Taylor, timekeeper; Mrs. J. Roberts, stenographer; J. Yu, chief engineer; and D. Botfield, surveyor.



GIANT MASCOT MINES LTD.

GENERALIZED PLAN

SHOWING SURFACE GEOLOGY AND MAJOR FAULT TRENDS

LEGEND

SURFACE DIORITE — ULTRABASIC CONTACT

FAULTS

ORE BODIES MINERALIZED ZONES

FEET 200 100 0 200 400 600 800 1000 1200 FEET

ALTAIR drafting, JUNE 3-69

GEOLOGY AND ORE CONTROLS

Walter E. Clarke

The author is a 1939 graduate of Queen's University in geology and mineralogy. From 1939 to 1941 he was assistant geologist for Buffalo Ankerite Gold Mines at South Porcupine, Ontario, and for the following four years was overseas in the Royal Canadian Engineers. On discharge, he returned to Buffalo Ankerite and was chief geologist until 1951. From 1952 to 1954 he was general superintendent of United Keno Hill Mines at Elsa, Yukon, with responsibility for all underground operations. In 1955, he was chief geologist of Geco Mines Limited at Manitouwadge, Ontario. From 1956 to 1959, Mr. Clarke was mine manager of the uranium project of Rayrock Mines Limited west of Yellowknife, N.W.T., and for the following six years he worked out of Rayrock's Toronto office as exploration manager with responsibility for Canadian and foreign projects. In 1966, Mr. Clarke established his own consulting practice in Vancouver. He is a registered professional engineer in the provinces of British Columbia and Ontario and is a member of the Canadian Institute of Mining and Metallurgy.

By WALTER E. CLARKE, B.Sc., P.Eng.

SUMMARY

The information presented in this report is based on the work of several geologists whose opinions have been summarized, where appropriate, in the body of the report, and preliminary interpretive work by the writer, over a period of three months. The primary conclusion drawn is that structure has played an important role in the control of ore bodies, and this approach should be a major consideration in planning future exploration. It is fully recognized that much more work is required to validate the present interpretations and investigate other geological conditions that may contribute to the control of ore deposition.

In general it is believed that all the intrusive rocks currently identified on the property are differentiates of the same basic-ultrabasic magma. The implications of this hypothesis are that nickel-bearing ultrabasic masses may be located within areas currently considered to be underlain by the unproductive dioritic and noritic facies of the intrusive complex, thereby appreciably increasing the potential of the property as a whole.

All rock types have been cut by faults which can be placed into four main groups, all related to known regional fault structures. The areas of intersection of N45° to 50°W striking faults and N10°W to N30°E striking faults appear to exert control over ore deposition. The northwest trend is considered to be the most important as mineralized areas and peridotite masses favour this direction. However, ore shoots have been localized along the northeasterly trending fault structures.

Time has not permitted investigation of the obvious spatial distribution of ore shoots relative to embayments in and proximity to the diorite and norite. The study of the chemical and mineralogical environment of the ore bodies is almost certain to make an important contribution to the overall interpretation of ore controls.

REGIONAL GEOLOGY

The mine is situated in a norite-diorite ultrabasic complex along the eastern edge of a granite, granodiorite and diorite intrusive mass, which is related to the Coast Range Batholith and the belt of acid intrusives extending southerly into Washington State. These rocks intrude northerly trending regionally metamorphosed Paleozoic sediments.

One of the main structural features of the Hope area is a regional northwesterly trending fault zone which extends from Lillooet southeasterly down the Fraser River to Boston Bar, to a point ten miles due east of Hope and thence on strike into Washington. The serpentine band along this fault signifies the strength of this structure. Parallel faulting has been observed at Laidlaw, ten miles west of Hope, and its northerly extension may be generally inferred by a series of serpentine and ultrabasic masses as far north as Cogburn Creek to the east of Harrison Lake. Northeasterly trending faults have been mapped at Laidlaw, as far southeast as the Giant Copper property, and probably are represented by Emory, Yale, Cogburn Creeks, etc. Prominent north-south faulting probably related to the main Fraser River fault occurs about midway between the mine and the Fraser River and marks the contact of the Paleozoic and Mesozoic rocks in this area. All of these fault directions have been recognized underground at the mine.

Of more than passing interest is a northwesterly trending zone of fracturing associated with ore bodies at both the Giant Mascot and Giant Copper properties, which on the regional surface picture may be represented by the Nicolum Creek-Sumallo River valleys from Hope to the Giant Copper property to the southeast. In a northwesterly direction, the trend is from Hope through the Giant Mascot mine and thence to the ultrabasic masses south of Cogburn Creek.

GEOLOGY OF THE PROPERTY

The surface extent of the main ultrabasic intrusive mass is approximately 1.8 miles in an east-west direction, by 1.4 miles north-south. At least three satellite ultrabasic bodies have been located; two 2,000 and 10,000 feet northwesterly and one 3,000 feet south of the main mass. The most detailed geological information has been obtained from production underground workings in the westerly third of the main intrusive complex, where the north-south dimensions decrease to between 1,000 and 2,500 feet.

The rock classification currently accepted at the mine is the result of several years' experience and the investigation of a number of geologists. The complex relationships and sometimes gradational transitions from one rock type to another, characteristic of intrusive masses of this type, lead to many incongruities, which are yet unresolved. For convenience, the rock types are categorized into ultrabasics, feldspathic and metamorphic rocks.

Ultrabasic Rocks
- Peridotite
- Pyroxenite
  - Bronzititic pyroxenite
  - Hornblende pyroxenite
    - Medium-grained hornblende pyroxenite
    - Poikilitic hornblende pyroxenite
- Hornblendite

Feldspathic Rocks
- Norite
- Diorite

Metamorphic Rocks
- Schist
- Hornfels
- Quartzite.

ULTRABASIC ROCKS

Peridotite

This rock is black in color and composed mainly of fine grained olivine crystals with more or less hornblende and pyroxene. The hornblende, where present, is usually in the form of large crystals which enclose olivine and pyroxene giving a poikilitic appearance. A peridotite composed entirely of olivine and therefore classed as dunite is found in a few localities. Crumbly alteration is characteristic of peridotites and is commonly in close proximity to ore bodies, although the alteration frequently exhibits no well defined boundaries, grades into fresh rock and is not obviously related to any structural feature, contact or later intrusion. The main alteration appears to be the development of talc along cracks and grain boundaries and patchy flakes of biotite. The peridotite frequently grades into pyroxenite with no visible contact. Some ore bodies are within peridotite masses.

Pyroxenites

The general classification includes the non-feldspathic rocks in which pyroxene is the major constituent, hornblende may vary considerably, and olivine is not recognizable. The following three types are the most common, but gradational phases can make differentiation difficult.

Bronzititic Pyroxenite.

Composed mainly of fine grained, equigranular brown pyroxene (bronzite) with minor hornblende content. The rock is very hard and tough. It may be mineralized with fine grained disseminated sulphides or may be completely barren. Classification may be difficult in border phases with diorite and the absence or presence of feldspar may be the only criterion to classify the rock as a pyroxenite or diorite.

Hornblende Pyroxenite

The medium-grained hornblende pyroxenite as the name implies is a felted mass of hornblende and pyroxene crystals in varying proportions with little or no olivine. The rock is hard and very tough, dark green to black and may be a host for ore bodies.

The poikilitic pyroxenite is similar to the above noted pyroxenite except that it contains many large crystals of hornblende. It may also be a host for ore.

Hornblendite

There are probably at least two types of hornblendite. The larger masses are composed almost entirely of equidimensional black hornblende crystals and usually occupy contact zones between pyroxenite and diorite. In some areas scattered sulphides have been noted, but no ore bodies have been found within this rock type.

Hornblendite dykes are found cutting all rock types on the property including crumbly alteration zones of the peridotite. The composition and texture of the dyke filling varies from fine grained black hornblende to pegmatitic hornblende with feldspar and is normally unmineralized.

FELDSPATHIC ROCKS

Norite

The mineral composition of this rock type is pyroxene and plagioclase feldspar in very variable proportions, giving a colour range from greyish through brown to green. In some areas, the feldspar is pinkish, thought to be the result of included ferric oxide. The rock is usually medium to fine grained and the pyroxenitic varieties exhibit gradational contacts with pyroxenite. Sulphide mineralization similar to that found in the main ultra-basic mass, may be present but in other areas the rock may be totally unmineralized and no ore occurs in this formation.

Diorite

This rock type is a variable mixture of hornblende and plagioclase feldspar, coarse to fine grained, and in some instances may exhibit gneissic structure. The colour varies from gray to greenish to brownish, depending upon the mineral composition. The brownish variety is usually equigranular, medium to fine grained and the presence of feldspar is the only megascopic characteristic distinguishing this from fine grained bronzititic pyroxenite. The rock is not a host for ore.

METAMORPHIC ROCKS

There are at least three types of metamorphic rocks, namely schist, hornfels and quartzites. The latter two types have been described by other geologists from surface examination, and have not been recognized by the writer in the underground workings. The hornfels are described as massive, black to dark brownish grey, very fine grained and compact. Some hornfels contain porphyroblastic crystals of brown pyroxene. The quartzites are light to dark grey, massive, an equigranular aggregate of fine to medium-grained quartz and feldspar crystals.

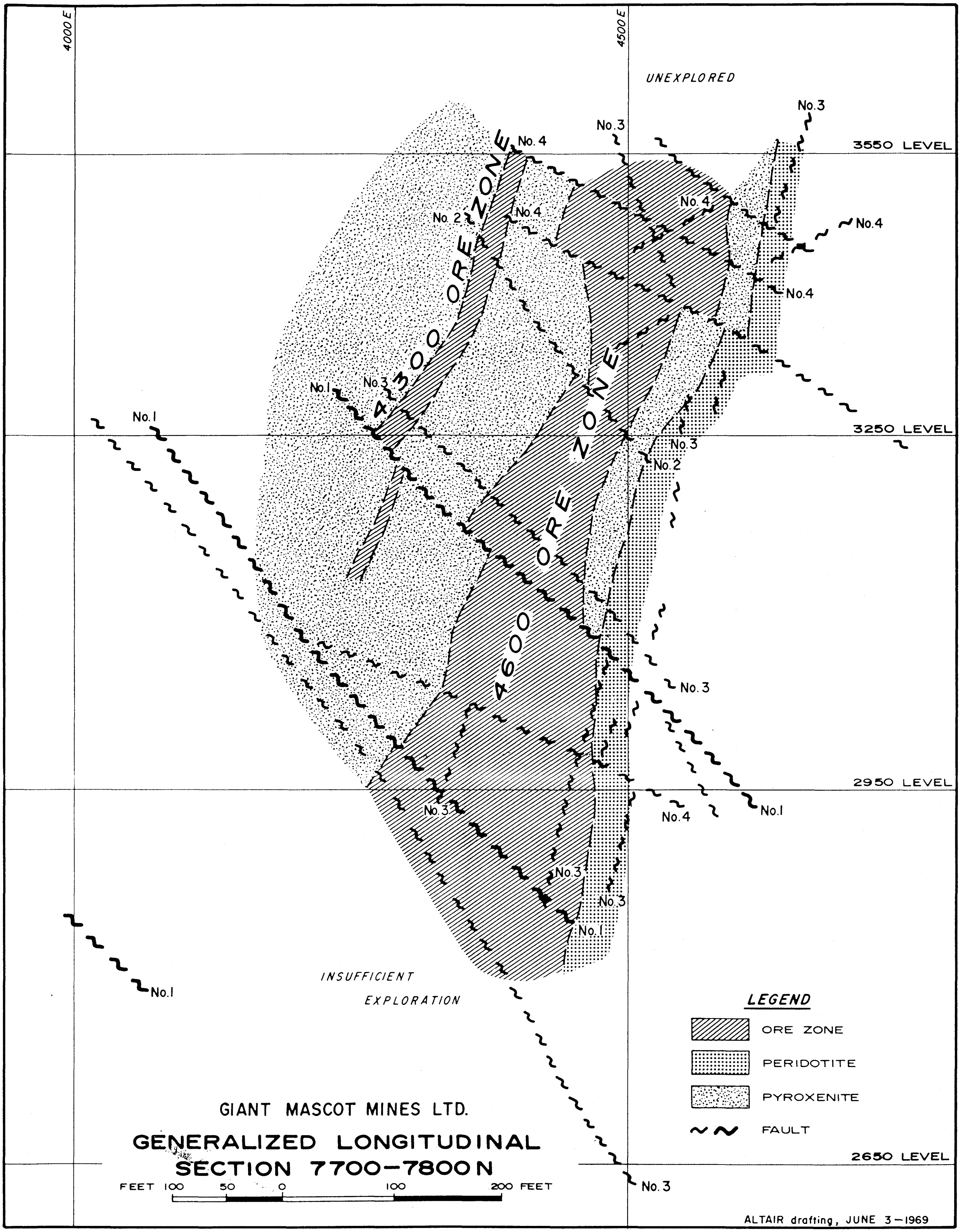
On surface, the schists are platey, schistose, greenish in colour and contain granular crystals of dark reddish brown garnet. Underground, the areas mapped as schist vary considerably in appearance, rarely contain garnets, but are well foliated with the development of sericite and biotite. The rocks are so highly metamorphosed that positive identification of the original rock type is difficult.

PETROGRAPHY

No comprehensive petrographic study of the various rock types has been carried out to date, but work done by Dr. P. A. Peach and others has brought to light significant characteristics of the intrusive complex.

Dr. Peach found that the pyroxenites are a local differentiation of peridotite. The diorites were classified as gabbro due to the calcic feldspar. The pyroxene in the diorite was the same composition as that in the ultrabasic facies, and he concluded that this rock type is a late differentiate of the magma which produced the peridodites. None of the rock types examined showed signs of secondary alteration, and the changes of olivine to serpentine and magnetite and of augite to hornblende took place during the initial crystallization history of the rocks, the process of autometamorphism.

Further petrographic work will aid



in determining the age relationships between the various rocks in the intrusive complex, an important hypothesis for establishing geological limits for exploration.

MINERALIZATION

Economic sulphide mineralization may be conveniently classified as disseminated or massive. Mineralogical studies by R. M. Thompson and A. R. Graham show the following average percentage sulphide content for the two types.

Sulphide	Disseminated Ore Ore to Gangue 1:3	Massive Ore
Pyrrhotite	45%	55%
Pentlandite	25%	30%
Violarite	10%	—
Pyrite	10%	10%
Chalcopyrite	5%	5%

In the disseminated ore, the sulphide minerals are interstitial to the silicates in the host rock and undoubtedly crystallized after the silicate minerals. Pyrrhotite is reasonably fresh, but pentlandite is partly converted to highly friable violarite. Secondly pyrite veinlets cut all other minerals and occasionally form replacement intergrowths with minor chalcopyrite.

In the massive sulphides, heavily fractured coarse pentlandite shows mutual boundaries with the massive host pyrrhotite. Under high magnification, small ragged exsolution laths of pentlandite are found in pyrrhotite, probably accounting for a considerable portion of the nickel content of pyrrhotite. Both sulphides are traversed by late pyrite veinlets, apparently following rehealed planes of shearing. Chalcopyrite is in irregular patches, associated sometimes with pyrite or as discrete areas on the contact of massive pentlandite with pyrrhotite, and apparently is later than both the latter two minerals. Chalcopyrite also occurs with mutual boundaries with minor pyrrhotite in fractures in pentlandite, as if some pyrrhotite continued to form during late stages of sulphide crystallization.

ALTERATION

As noted above, there is very little evidence of secondary alteration within the intrusive complex. Exceptions to this are the development of secondary actinolite, talc, chlorite, serpentine and in some cases magnetite, in direct association with shearing and faulting, and development of talc and biotite in the "crumbly alteration" areas mainly within peridotites. The cause of this latter alteration type is obscure as the alteration is not obviously related to any structural feature, contact or later intrusion.

The presence of greater than normal percentages of hornblende in pyroxenites in close proximity to some ore bodies suggests the metamorphism of pyroxene to hornblende, but until further petrographic work is done, this can only be speculative.

FAULTING

(Reference Maps No. 1 and No. 2)

Widespread faulting is in evidence throughout the underground workings and the main fault trends are tentatively categorized as follows:

Group	Strike	Dip
1	N45° - 50°W	50° -75°N.E
2	N15° - 30°E	70°S.E.-70°N.W
3	N10°W- 10°E	55°E. -55°W.
4	N30°W-N30°E	20° -30°E or W

The faults included in No. 1 group are closely associated with several of the main bodies and partially explored mineralized areas, and may be related to the regional northwesterly trending zone postulated as extending from the Giant Copper property to the southeast, through Giant Mascot and northwesterly to the ultrabasics at Cogburn Creek. At least four such fault systems have been recognized, each of which in all probability is made up of several parallel or subparallel discontinuous strands, across a total width up to 300 feet to 400 feet. The main systems are located in the Brunswick ore bodies area; along the trend of the 1400, 1900, 4600 and possibly Pride of Emory ore shoots; a mineralized area in 512 crosscut on the 3550 level; the Trail zone in the Chinaman's Tunnel, 3275 level. Elements of this fault type have been found to dam or cut off mineralization, and provide a favourable structural environment for important ore extensions of the 4600 ore body. It is concluded that these faults are preore in age, with minor post-ore movement.

The faults of the second group are most readily recognized by their close association with tabular ore bodies exemplified by the 600 and 1600, and the mineralized zone in 512 crosscut.

The faults of No. 3. Group are probably closely related to those of No. 2. They are common to all mineralized zones examined, and are frequently more readily recognizable in disseminated ore zones or host rocks, as within massive sulphides they may only be identified as discontinuous joints displaying similar attitudes. In some cases, massive ore blocks within a general mineralized area will be bounded by such fracture planes, while in other cases there has been no obvious affect on the ore outline. Movement along this fault direction is exhibited by the development of talc, a condition which might cause damming of ore solutions. These faults are probablly related to the regional system which has been observed on surface two miles east of the mine.

The above three fault systems appear to have combined to set up complicated zones of fracturing, favourable to the concentration of sulphides.

Faults of the 4th group are quite strong in appearance, usually associated with 8 inches to 2 feet of crushed wall rock and gouge material and often characterized by the introduction of feldspathic and carbonate minerals, with bleaching of the crushed material. It is believed that these faults are later in age than the other three groups, and exhibit post ore movement. While not observed by the writer, it is reported that certain ore shoots, for example the 600 and 1500, terminate against such structures. The offset portions of these ore shoots have not yet been located, so the direction or amplitude of movement are unknown. These faults are probably related to the northwesterly trending Fraser River regional thrust fault system.

There are other fracture systems on all levels, exhibiting varying attitudes, the correlation of which has not yet been attempted.

FOLDING

No folds as such have been recognized to date. The occurrence of faulting and fracturing, with parallel strikes but opposing dips, may indicate the presence of former folds, dome structures or other zones of disturbance or weakness, which exerted control over the distribution of the intrusives. Much additional interpretive work is necessary to substantiate this idea.

ORE CONTROLS

The recognition of ore controls is of primary importance, as compared to the extent of the basic to ultrabasic intrusive complex known ore bodies are relatively small. The problem has been studied by geologists over the past several years, but as yet is unresolved.

Eric S. Cheney and Ian M. Lange in their paper "Evidence for Sulphurization and the Origin of Some Sudbury-Type Ores", May 1967, considered the relevancy of this hypothesis as it relates to the Mascot ore bodies. The sulphurization hypothesis suggests that any mafic intrusion carrying at least trace amounts of nickel, copper or cobalt may contain ore at or near its contacts. Large ore bodies may be restricted to those intrusions containing more siliceous differentiates exhibiting gradational, sharp, and mutually crosscutting contacts with the principal rock types. Exploration should be directed towards finding these differentiates and intersections of former permeable (dilation) zones with the most nickel-rich portion of the intrusions.

A. R. Graham, as the result of his mineralogical study of Mascot ore, concludes:

"The ore-bearing bodies appear to be ultrabasic masses, high in sulphur, intruded as a crystal mush, lubricated by a considerable proportion of relatively high-nickel sulphide fluid. This silicate-sulphide magma was probably formed by differentiation at depth, and intruded into its present position under a thick cover to prevent much sulphur loss by degassing. Late movement after almost complete solidification of the composite fluid provided dilation zones into which the interstitial sulphides were probably filter-pressed to form the high-grade massive bodies.

G. E. P. Eastwood states: "that the localization of ore appears to have been controlled largely by the chemistry and physical chemistry of the rocks and of the processes to which they have been subjected."

A. E. Aho believes that all dykes, faults and fractures and the related alteration are post-ore and consequently have no control over ore deposition.

E. R. Gayfer, Chief Engineer, Giant Mascot Mines Limited, made a geometrical analysis of the shapes of horizontal sections of the ore bodies and concluded that the shape of each ore body could be related to three, or in some cases four intersecting fracture planes.

The widespread faulting in evidence throughout the underground workings impressed the writer during early examinations. The faults, although individually of minor intensity with probably little post-ore movement, show distinct continuity and the relationships of intersecting fault systems with known ore bodies and mineralized zones presented interesting implications. Despite the conflicting opinions summarized above, it is believed that an interpretation of the fault patterns will lead to a better understanding and possibly a solution of ore controls. The study is still in a very preliminary stage, but certain structural conditions appear worthy of continued investigation. The characteristics and some of the effects of the fault systems have been referred to in the preceding section under "Faulting".

The N45° to 50°W trending fault systems are considered to represent the final adjustments along pre-ore structures which provide channelways for the intrusion of the ultrabasic and basic magma differentiates, including sulphide minerals. On a regional basis, ultrabasic and nickeliferous showings may be traced along this trend from Hope to Cogburn Creek. Within the mine area, there is lineation of ore bodies, zones of mineralization and, less obviously, masses of peridotite, along four such parallel trends. In detail individual ore bodies are controlled at least in part, by recognizable fault strands of this system.

The generally north-south striking faults with dips in excess of 50°, which may include the faults in both groups No. 2 and 3, represent the next most important structural trend. As with the northwesterly trending structures, these faults may represent the final adjustments along pre-ore zones of weakness, and in the case of the 600 and 1600 ore bodies have provided access for the introduction of ore solutions. In the 4600 ore body, a N10°E striking fracture system marks the southeast extremity of the ore zone, which has been traced from below the 2950 level to the 3550 level. N10° to 20°W shears mark massive sulphide interconnections between parallelling northwesterly mineralization trends.

As further evidence of the importance of faulting, it has been noted that ore bodies may occur in both peridotite or pyroxenite, with the only obvious reason for selectivity in any area being the presence of one or both of the above fault systems. The plunges or rakes of ore bodies mined to date show a marked variation in attitude, even within the same ore body. It appears possible that such variation may be explained by the change of ore control from one fault system to another.

Detailed analysis of former producing areas is hampered by inaccessibility and lack of detailed structural information, but it is anticipated that the continuing study of the 4600 zone will provide many answers to the problem of ore controls.

The possibility of the flatly dipping group No. 4 fault offsetting or otherwise interrupting the continuity or ore shoots must be considered and investigated in more detail.

The general conclusions are that structural control of ore bodies is a distinct possibility and until further evidence qualifies this interpretation, the intersection of the N50°W and generally north-south striking fault systems within the ultrabasic rocks constitute areas most amenable to ore deposition.

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